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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Applicant: HEED, Bjorn	) Examiner: Leo
Serial Number: 08/737,042	) Art Unit: 3743
Filed: October 30, 1996	)
For: HEAT EXCHANGER AND METHOD FOR ITS MANUFACTURE	)
Docket Number: 5098	)

SECOND SUBSTITUTE APPEAL BRIEF

Mail Stop Appeal Brief – Patents
Commissioner of Patents
Box 1450
Alexandria, VA 22313-1450

20 July 2006

Sir:

In response to the Notification of Non-Compliance with the Requirements of 37 CFR §41.37(c) dated 6 June 2006, Applicant submits this Second Substitute Appeal Brief. Accordingly, this Substitute Brief is timely filed on 20 July 2006.

This Second Substitute Brief corrects the Section headings to comply with 37CFR §41.37(c). The Second Substitute Brief includes a

more detailed explanation of the subject matter defined in each of the independent claims (See, e.g. pages 14 - 20). The Second Substitute Brief includes an Evidence Appendix beginning on page A4 and a Related Proceedings Appendix on page A68.

This is an Appeal Brief from the Final Rejection dated November 18, 2003 of Claims 5 and 7 -11. Applicant filed a Notice of Appeal on March 17, 2004. The Notice of Appeal was received by the USPTO on March 22, 2004. Accompanying this brief is a petition of a five-month extension of time for May 22, 2004 up to an including October 22, 2004 and the fee set forth under 37 CFR 1.17(a)(5). Accordingly, the original brief wass timely filed on October 22, 2004.

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I. Real Party in Interest

The real party in interest is inventor Bjorn Heed.

II. Related Appeals and Interferences

Applicant's legal representatives submit that there are no known appeals and interferences related to this appeal.

III. Status of the Claims

Claims 5 and 7-11 are pending in the above application. These claims presently stand rejected, pending appeal.

Claims 5 and 9 were rejected under 35 USC §103(a) as being unpatentable over SU 800,500 (*ACV*) in view of GB 1339542 (*Usher*).

Claims 7-8 and 10 - 11 were rejected under 35 U.S.C. § 103(a) as being unpatentable over *ACV* in view of *Usher* and in further view of US Patent No. 4407357 (*Hultgren*).

Applicant appeals to the Board of Appeals from the Office Action dated November 18, 2003 finally rejecting Claims 5 and 7-11.

IV. Status of the Amendments

No claims were amended after Final Rejection. An amendment to the specification was filed contemporaneously with the brief. Amendments were made to the specification to address the Examiner's objections that the specification lacked section headings and that there was no description in the specification related to Figures 5-7. No new matter was added.

V. Summary of Claimed Subject Matter

A. Summary of the Claimed Subject Matter

The present invention relates to a recuperative heat exchanger for the transfer of heat between two media through a heat transferring wall, and a method of producing such a heat exchanger. Heat exchangers are used for the transfer of heat between two media flows of different temperatures. In a recuperative type heat exchanger, heat is transferred from the hot medium through a separating wall to the cooler medium.

If the heat exchanger is to serve its function of transferring heat it is important that the heat transfer surface area is as large as possible. This is often accomplished by dividing the media flows into multiple parallel part flows moving inside alternatingly juxtaposed passageways to form a unit with a large transfer surface area within a limited volume.

Except when subject to boiling or condensation the media change their temperature as they pass through the heat exchanger. The temperature of the hot medium gradually decreases and the temperature of the cooler medium gradually increases. When the temperature difference between the media is small it is important that the flow geometry in the heat exchanger is such that the hottest part (the beginning) of the hot flow heats the hottest part (the end) of the cool flow and that the coldest part (the end) of the hot flow heats the coldest part (the

beginning) of the cool flow. The use of countercurrent flow geometry in the heat exchanger makes it possible to achieve such a degree of heat exchange that the outgoing temperature of the cool flow is higher than the outgoing temperature of the hot flow. This is not possible when using a flow geometry where the media travel in the same direction through the heat exchanger, i.e. so called parallel flow heat exchangers. (Application at page 1, line 8 – page 2, line 10).

To achieve optimum heat transfer in the heat exchanger it is necessary that the heat transfer between each medium and the separating wall is as good as possible. This can be accomplished by designing the separating wall in such a manner that it promotes the generation of a turbulent, well mixed, vortex filled flow in the medium that is in contact with the wall. In the present inventive heat exchanger the flow is arranged so as to be distributed over several parallel passageways in such a way that the passageways are alternatingly in juxtaposed relationship so there is as large total heat transfer surface area. The heat transfer walls in the inventive heat exchanger contribute to the generation of a turbulent flow with good heat transfer to the wall. Their inventive heat-exchanger uses counter-current flow of the media in the heat exchanger. (Application at page 2, line 11 – 30).

Figure 1 in a perspective view shows important steps of the manufacture of a heat exchanger according to the present invention. Figure 2 is a

perspective view of a heat exchanger according to the invention depicted in a not fully closed state in order to show the internal flows of the media. Figure 3 is a perspective view of a part of the heat transferring walls in the same heat exchanger. Figure 4 is a perspective view of a heat exchanger according to the invention in accordance with a slightly different embodiment and shown in a not fully closed state. Figure 5 is a top view of a portion of the heat exchanger. Figure 6 is a top view of the portion of Figure 5 after it has been folded and Figure 7 is a section of Figure 5. (Application at page 3, lines 4 – 15 and Amendment filed October 22, 2004).

A heat exchanger according to the invention preferably is produced from a continuous sheet 1 of metal, plastic or other suitable material, which in the completed heat exchanger will serve as a heat-transferring wall. In Figure 1, reference numbers 2 and 3 denote rollers between which the sheet is fed in the direction of arrow 4. The surfaces of the rollers are formed with patterns of oblique ridges and grooves 5 and 6. Furthermore, the rollers are formed with ridges 7 and grooves 6 extending parallel with the roller axis. Every ridge 7 corresponds to a groove 8 on the opposite roller. Accordingly, when the sheet passes between the rollers, the ridges 7 and the grooves 8 form folding lines 9 in the sheet. In sequence along the circumference of each roller, a ridge 7 is followed by a groove 8. Accordingly, the folding lines are be pressed alternatingly in one side and then in the opposite side of the sheet. This makes it easy to fold the sheet at the folding lines into a package 10 comprised by a number of

juxtaposed layers. The oblique pattern 5 and 6 on the rollers gives the band a corrugated configuration best visible in the encircled enlargement 11 in Figure 1. The sheet is cut to suitable lengths so that an appropriate thickness of the package 10 is obtained. (Application at page 3, line 16 – page 4, line 1).

In Figure 1, a complete finished package is represented by numeral 12. The ends of the package 12 are closed by covering elements 13. The covering elements may be produced by dipping the package ends into a soft compound that hardens or solidifies when cooled or through a chemical reaction. Reference number 14 is a sealing strip that is applied to one side of the package, e.g. the bottom part. A corresponding seal, not visible in the drawing, is applied to the opposite side of the package. Reference number 15 denotes a box-shaped casing 15 generally, into which the package 12 is intended to be placed as indicated by arrow 16. When the package is placed inside the casing, the seal 14 will be forced against the bottom of the casing and covering elements 13 will seal against the end walls 17 and 18 of the casing. Preferably, the width B of the package 12 essentially corresponds to the spacing between the sidewalls 19 and 20 of the casing while the height H of the package essentially corresponds to the height of the casing. The casing 15 has a lid 21. The shape of the lid matches that of the open upper side of the casing 15. At the corners of the casing 15 connecting ports 22 23,24 25 are arranged. The connecting ports 22 and 25 serve as inlet and outlet ports respectively

for one medium and connecting ports 23 and 24 serve as inlet and outlet ports respectively for the other medium. When the lid 21 is fitted while the package 12 is in the casing 15 the lid will seal against the top face of the package 12. The sealing strips 14 and the covering elements 13 prevent the two media from mixing and thus the media are kept separate, one on either side of package 12 and thus on either side of the folded sheet. (Application at page 4, lines 1 – 33).

Figure 2 shows the upper part of the package slightly raised to illustrate the flow paths of the two media. The directions of flow are shown by arrows 26 for one medium and by arrows 27 for the other medium. As is most clearly apparent from Figure 3, the corrugations in one layer of the folded sheet extend crosswise with respect to the corrugations in the next layer. These crossing corrugations formed in the facing sides of adjacent layers create a turbulent flow in the medium flowing between the layers. This contributes to an efficient exchange of heat between the two media. (Application at page 4, line 33 – page 5, line 8).

In the example shown the sheet is given a corrugated pattern but within the scope of this invention shaped patterns of different configuration that create turbulence in the inter-layer space may also be used. In the example shown the shaped pattern was made by means of rollers, but the shaped pattern can also be accomplished by stamping. As mentioned above, the covering elements 13 are made of a solidifying compound. However, it is within the scope of the invention to produce the

covering elements 13 as separate lids which with an intermediate soft layer that is pressed against the ends of the package. It is also possible to use layers of soft material between the ends of the package and the end walls of the outer casing. The casing 15 and the lid 21 thus form an outer shell that together with the seals 13 and 14 on the package 12 constitutes an efficient media flow separating and sealing means. The seal shown in the figures could however, be made in a very simple and inexpensive manner. The application of the sealing compound or other soft material can be made without high precision or geometrical exactness. A sealing effect could also be accomplished by a good fit only or by soldering or welding when suitable materials, therefore are used. (Application at page 5, line 9 – 31).

In contrast to the example described above, wherein a casing 15 with a lid 21 forms a shell around the package 12, this shell is formed according to Figure 4 by a box 28 having a rectangular cross sectional shape. On one side, the box is equipped with an inlet port 29 and an outlet port 30 for one of the media and on the other side with an inlet port 31 and an outlet port 32 for the other medium. In this example the package 12 is inserted through one open end of the box which thus forms a casing 33 which may be closed by lids 34 and 35. The lids 34 and 35 are designed to seal against the ends of the package 12, either by themselves or by means of intermediate sealing layers. The lower lid 34 in Figure 4 could for instance be fastened by means of a liquid sealing compound which is poured into the lid and which solidifies after the assembly 28, 12 has

been dipped into it. The other lid 35 can then be fastened in the same way after the assembly 28, 12 having been turned upside down. This kind of molding can also be used in the example shown in Figures 1 and 2. When using an appropriate sealing compound the lids may be removed after the molding operation and thus only serve as moulds in the molding process.

The shaped pattern in the sheet serves at least three purposes. One is to establish a certain distance or pitch between successive layers in the folded sheet so that a medium can flow in the inter-layer space. The shaped pattern should also promote turbulence in the flow as described earlier.

The simple pattern described above serves both these purposes. As mentioned above, after folding of the sheet the oblique corrugations form a system of crossing ridges. The ridges maintain a certain spacing between the different folds and produce a tortuous, turbulence inducing flow path for the medium which, as mentioned above, promotes heat transfer to the wall.

Owing to the design of the heat exchanger, the two media flows are distributed over a number of parallel channels that are placed in alternating nesting position. The third purpose of the shaped pattern is to achieve an evenly distribution of the flow sideways within and across each channel. Thus an essentially counter-current flow pattern is established between the two media flows even when their inlet and outlet ports do not extend in the prolongation of the flow direction. (Application at page 5, line 32 – page 7, line 29).

An efficient lateral spread of the flow of this kind is achieved if the resistance to flow sideways is lower than the resistance of flow lengthwise in the channel. This result is obtained with the proposed simple corrugation of the sheet if the angle of the corrugations to the longitudinal extension of the sheet is less than 45°, or differently expressed, if the angle of the corrugations to the intended direction of flow is more than 45°. (Application at page 7, line 1 - 10).

The simple corrugation pattern which has been used as an example above is easy to produce between two helically cut rollers as in Figure 1. It is also well suited to fulfill the objects of keeping the spacing between the layers, and of promoting turbulence and lateral distribution of the flow as have been discussed above. Many other stamped patterns are also possible, as mentioned above. To facilitate the folding of the sheet the corrugations preferably could be interrupted and be replaced by folding lines at suitable spaced-apart intervals as shown in Figure 1. Another improvement of the pattern would be to provide the inlet and outlet areas (the outer parts of the sheet) with a different pattern from the main part of the sheet area so as to give an efficient lateral distribution of the flow without making the lengthwise resistance to flow too high in the main part of the heat exchanger. A reduction of the resistance to flow in the heat transferring part of the heat exchanger most often however invovles a reduction of the heat transfer there, which is not desirable. (Application at page 7, line 11 - 30).

Figure 5 shows a portion of the heat exchanger with ridges, viewed from above, two ridges marked in red, with a corresponding valley between. On the other side of the fold line, the continuing ridges are shown marked in purple. When folded in the assembled position, as shown in Figure 6, the ridges fold at the points where the red and the purple intersect. The black lines represent regions where the bottom of each valley is farthest from each other. Figure 7 shows a section of Fig. 5, with the ridge peaks shown in red. (Amendment filed October 22, 2004).

B. Concise Explanation of the Subject Matter Defined in Each Independent Claim

1. Concise Explanation of the Subject Matter Defined in Independent Claim 5

Independent Claim 5 is a recuperative heat exchanger for the exchange of heat across a plurality of heat transferring planer elements between a first fluid medium and a second fluid medium. The fluid mediums flow in opposite directions to each other on opposite sides of the planar heat exchanger. (See, e.g. Figures 2 – 4).

The heat exchanger comprises a casing for containing the heat transfer package. The casing having a top end, a bottom end, a pair of respective lengthwise and widthwise opposed sides. Each lengthwise side is provided with a pair of inlet and outlet ports. Each respective pair of inlet and outlet ports is dedicated to one of the first and second mediums

for flow therethrough. (See, e.g. Application at Page 4, lines 19 – 29 and Figs. 2 and 4).

The heat transfer package is disposed within the casing. The heat exchange package having a lengthwise extent and a widthwise extent. Each of the fluid mediums following on their respective side of the planar elements a net flow path which extends longitudinally along the lengthwise extent. The package comprised of a plurality of generally rectangularly shaped planar elements continuously arranged in sequentially alternating directions in a folded accordion-like manner. (See, e.g. Application at Fig. 1 and 2). Each of the planar elements having substantially similar length, width and thickness with respect to each other. Each of said planar elements integrally connected to an adjacent planar element along said length. (See, e.g. Application at Fig. 1 and Page 3, lines 16 – Page 4, line 1). The length and width of the casing substantially corresponding to the length and width of said package. Opposing surfaces from each adjacent planar element defining an inter-layer space therebetween for receiving a flow of one of said fluid mediums therebetween. (See, e.g. Application at Page 4, lines 21 and Figs. 1 and 2). A direction of flow of each medium having a widthwise element and a lengthwise element when flowing within said inter-layer space. Each of said planar elements having a corrugated pattern formed therein. (See, e.g. Application at Page 4, line 37 – Page 5, line 8 and Fig.

3). The corrugated pattern extending the entire length and width of each respective planar element. (See, e.g. Application at Page 4, line 37 – Page 5, line 8 and Fig. 3). The pattern corresponding to a series of alternating ridges and channels extending across the width of each respective planar element formed at an angle of more than 45 degrees with respect to said length of said planar elements. (See, e.g. Application at Fig. 3). The pattern, in respect to the net flow path, are oriented in a more transverse than lengthwise direction. (See, e.g. Application at Page 4, line 37 – Page 5, line 8 and Fig. 3). The corrugated pattern interrupted at substantially similar intervals to include a fold line for facilitating arranging each of said planar elements in an accordion-like manner. (See, e.g. Application at Page 3, lines 24 – 35 and Figs. 1 and 3). The fold lines defining said width of each respective element and being disposed parallel along said length of each of said elements, wherein when said heat transfer package is in an unfolded state, a pattern of ridges and channels of a first planar element is generally aligned with respect to a pattern of channels and ridges of a successive planar element. (See, e.g. Application at Page 3, lines 24 - 35 and Figs. 1 and 3).

When said heat transfer package is in a folded state, the pattern on every other planar element is co-extensive to the other and said ridges and channels between facing sides of adjacent planar elements form a

crossing pattern to each other such that said crossing pattern creates a flow resistance to said respective fluid medium flowing over said respective side of said planar element. (See, e.g. Application at Fig. 3). The ridges and channels being arranged at an angle greater than 45 degrees with respect to a line arranged in a direction along the lengthwise extent so as to present a flow resistance greater in the lengthwise extent direction than the widthwise extent direction. (See, e.g. Application at Page 7, lines 2 - 10 and Fig. 3). The angle of the ridges and channels tending to increase the overall pressure drop across the heat exchanger compared to smaller angle configurations and force the fluid medium to travel more readily in the widthwise directions before exiting the heat exchanger, the angle of the ridges and channels arranged to force the fluid medium to exhibit a substantially thermally balanced flow distribution across the widthwise extent of the heat exchanger surfaces, thereby increasing flow turbulence and heat transfer. (See, e.g. Application at Page 6, line 17 - Page 7, line 34).

2. Concise Explanation of the Subject Matter Defined in Independent Claim 9

Independent Claim 9 is a recuperative heat exchanger for the exchange of heat across a plurality of heat transferring planar elements between a first fluid medium and a second fluid medium, said fluid mediums flowing in opposite directions to each other on opposite sides of

said planar elements. (See, e.g. Figures 2 – 4). The heat exchanger of Claim 9 comprises a casing for containing a heat transfer package therein. The casing having a top end, a bottom end, a pair of respective lengthwise and widthwise opposed sides. Each of the lengthwise sides is provided with a pair of inlet and outlet ports, wherein each respective pair of inlet and outlet ports is dedicated to one of said first and second mediums for flow therethrough. (See, e.g. Application at Page 4, lines 19 – 29 and Figs. 2 and 4).

The heat exchanger comprises a heat transfer package disposed within said casing. The heat exchange package having a lengthwise extent and a widthwise extent, each of the fluid mediums following on their respective side of the planar elements a net flow path which extends longitudinally along the lengthwise extent.

The package is comprised of a plurality of generally rectangularly shaped planar elements continuously arranged in sequentially alternating directions in a folded accordion-like manner. (See, e.g. Application at Fig. 1 and 2). Each of the planar elements having substantially similar length, width and thickness with respect to each other, each of said planar elements integrally connected to an adjacent planar element along said length, said length and width of said casing substantially corresponding to said length and width of said package. (See, e.g. Application at Fig.1 and Page 3, line 16 – Page 4, line 1). Opposing surfaces from each adjacent

planar element defining an inter-layer space therebetween for receiving a flow of one of said fluid mediums therebetween. The direction of flow of each medium having a widthwise element and a lengthwise element when flowing within said inter-layer space. (See, e.g. Application at Page 4, line 21 and Figs. 1 and 2).

Each of said planar elements has a corrugated pattern formed therein. (See, e.g. Application at Page 4, line 37 – Page 5, line 8 and Fig. 3). The corrugated pattern extends the entire length and width of each respective planar element. (See, e.g. Application at Page 4, line 37 – Page 5, line 8 and Fig. 3). The pattern corresponds to a series of alternating linear ridges and channels extending across the entire width of each respective planar element. The corrugated pattern is interrupted at substantially similar intervals to include a fold line for facilitating arranging each of said planar elements in an accordion-like manner. The fold lines defining said width of each respective element and being disposed parallel of said length of each of said elements. (See, e.g. Application at Page 3, lines 24 – 35 and Figs. 1 and 3).

When the heat transfer package is in an unfolded state, a pair of ridges and channels of a first planar element is generally aligned with respect to a pattern of channels and ridges of a successive planar element. (See, e.g. Application at Page 3, lines 24 – 35 and Figs. 1 and 3). The flow path has means for creating a flow resistance to the

respective mediums such that the flow resistance to the respective mediums flowing over said respective side of said planar elements is greater in said lengthwise direction of said heat transfer package than in said widthwise direction, thereby increasing flow turbulence and heat transfer. (See, e.g. Application at Page 6, line 17 - Page 7, line 34 and Fig. 3). The means for creating the flow resistance is ridges and channels being arranged at an angle greater than 45 degrees with respect to a line arranged in a direction along the lengthwise extent. (See, e.g. Application at Page 7, lines 2 – 10 and Fig. 3).

VI. Grounds of Rejection to be Reviewed on Appeal

A. Issues

Whether claims 5 and 9 are unpatentable under 35 USC §103(a) as being obvious over SU 800,500 (ACV) in view of GB 1339542 (Usher)? Whether claims 7–8 and 10 –11 are unpatentable under 35 U.S.C. § 103(a) as being obvious over ACV in view of Usher and in further view of US Patent No. 4407357 (Hultgren).

B. Grouping of Claims

Claims 5 and 7-11 are pending in the above application. These claims presently stand rejected, pending appeal.

Claims 5 and 9 were rejected under 35 USC §103(a) as being unpatentable over SU 800,500 (*ACV*) in view of GB 1339542 (*Usher*).

Claims 7–8 and 10–11 were rejected under 35 U.S.C. § 103(a) as being unpatentable over *ACV* in view of *Usher* and in further view of US Patent No. 4407357 (*Hultgren*).

Claims 5 and 9 are separately patentably from claims 7–8 and 10–11.

VII. <u>Argument</u>

A. Claims 5 and 9 are Patentable over *ACV* in view of *Usher*

Independent claims 5 and 9 are recuperative heat exchangers for the exchange of heat across a plurality of heat transferring planar elements between a first fluid medium and a second fluid medium, said fluid mediums flowing in opposite directions to each other on opposite sides of said planar elements. Claim 5 contains numerous limitations, including but not limited to:

- said [corrugated] pattern [on the planar elements] corresponding to a series of alternating ridges and channels extending across the width of each respective planar element formed at an angle of more than 45 degrees with respect to said length of said planar elements, which pattern, in respect to the net flow path, are oriented in a more transverse than lengthwise direction

- said pattern on every other planar element is co-extensive to the other and said ridges and channels between facing sides of adjacent planar elements form a crossing pattern to each other such that said crossing pattern creates a flow resistance to said respective fluid medium flowing over said respective side of said planar element, the ridges and channels being arranged at an angle greater than 45 degrees with respect to a line

arranged in a direction along the lengthwise extent so as to present a flow resistance greater in the lengthwise extent direction than the widthwise extent direction, the angle of the ridges and channels tending to increase the overall pressure drop across the heat exchanger compared to smaller angle configurations and force the fluid medium to travel more readily in the widthwise directions before exiting the heat exchanger, the angle of the ridges and channels arranged to force the fluid medium to exhibit a substantially thermally balanced flow distribution across the widthwise extent of the heat exchanger surfaces, thereby increasing flow turbulence and heat transfer.

Claim 9 includes numerous limitations, including but not limited to:

- said flow path has means for creating a flow resistance to said respective mediums such that the flow resistance to said respective mediums flowing over said respective side of said planar elements is greater in said lengthwise direction of said heat transfer package than in said widthwise direction, thereby increasing flow turbulence and heat transfer.

Claims 5 and 9 were rejected under 35 USC §103(a) as obvious over SU 800,500 (*ACV*) in view of GB 1339543 (*Usher*). Claims 5 and 9 are patentable over *ACV* in view of *Usher*. First, one skilled in the art would not combine *ACV* and *Usher*. Second, *ACV* and/or *Usher* alone or in combination do not teach a heat exchanger with all the elements of claims 5 and 9.

1. One Skilled in the Art would not combine *ACV* with *Usher*

Claims 5 and 9 include numerous limitations. The limitations of claims 5 include but are not limited to that "the angle of the ridges and channels arranged to force the fluid medium to exhibit a **substantially**

thermally balanced flow distribution across the widthwide extent of the heat exchanger surfaces, thereby **increasing flow turbulence** and heat transfer." The limitations of claim9 include, but are not limited to that "the **flow resistance to said respective mediums flowing over said respective side of said planar elements is greater in said lengthwise direction** of said heat transfer package than in said widthwise direction, thereby **increasing flow turbulence** and heat transfer."

A reference teaches away from the claimed invention when it leads one skilled in the art in the other direction from the claimed modification. Usher teaches away from a thermally balanced flow distribution and increased flow turbulence. The flow in *Usher* is changes direction along the individual sheets comprising the exchanger package, such that the flow pattern from one plate to the next is changed. This results in an uneven flow distribution from plate to plate and reduced turbulence.

The present heat exchanger design and orientation on the other hand requires flow to proceed along the length of each sheet in the same direction, such that the two mediums are proceeding on each side of a sheet in exactly the same manner, thereby balancing the flow distributions and increasing turbulence.

Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention without some teaching

suggestion, motivation or incentive to support the combination. See, *e.g. In re Lee*, 277 F.3d 1338, 1342-43 (Fed. Cir. 2002); *In re Fritch*, 972 F.2d 1260, 1265-67 (Fed. Cir. 1992); and *ACS Hosp. Sys., Inc. v. Montefiori Hosp.*, 732 F2d 1572, 1577 (Fed. Cir. 1984). Here there is not teaching, suggestion or motivation to combine *ACV* and *Usher*.

ACV is directed to a nozzle made from paper impregnated with thermoplastic resin. Partial polycondensation of the resin is carried out, a solvent moistens the bending lines, and then complete polycondensation of the resin is carried out. *ACV* addresses special problems associated with bending paper into a heat exchanger shape and thus discusses the fold lines. There is not teaching or suggestion in ACV related to the angles or pattern of the corrugations. There is no discussion of the flow distribution. *Usher* has unbalanced flow distributions and reduced turbulence.

Because *Usher* teaches away from a balanced flow distribution and increased turbulence, one skilled in the art would not combine *Usher* and *ACV* to create a heat exchanger with all the limitations of claims 5 and 9 such as a balanced flow distribution and increased flow turbulence. Thus, claims 5 and 9 were improperly rejected under 35 USC §103(a) as being obvious over *ACV* and *Usher*.

2. *ACV* and/or *Usher* Alone or in Combination Do Not Teach a Heat

Exchanger with All the Limitations of Claims 5 and 9.

ACV is directed to a nozzle made from paper impregnated with thermoplastic resin. Partial polycondensation of the resin is carried out, a solvent moistens the bending lines, and then complete polycondensation of the resin is carried out. *ACV* addresses special problems associated with bending paper into a heat exchanger shape. *ACV* discusses fold lines. It does not discuss the angles of the corrugations or corrugation pattern. There is no teaching or suggestion in *ACV* related to the angles or pattern of the corrugations or to the flow distribution.

Usher does not make up the deficiencies in ACV. *Usher* was said to disclose a heat exchanger for two fluids comprising a plurality of rectangular plates, wherein the angle of the ridges and channels are 30 degrees with respect to the width of the plate (i.e. 60 degrees with respect to the length of the plate) for the purpose of improving heat exchange. The flow of *Usher* changes direction along the individual sheets comprising the exchanger package, such that the flow pattern from one plate to the next is changed. This results in an uneven flow distribution from plate to plate and reduced turbulence.

The present heat exchanger design and orientation on the other hand requires flow to proceed along the length of each sheet in the same direction, such that the two mediums are proceeding on each side of a

sheet in exactly the same manner, thereby balancing the flow distributions as a means of maximizing heat transfer.

ACV and/or *Usher* alone or in combination do not teach or suggest a continuous heat exchange package element where the pattern is formed on the entire planar element and which orientates the package such that the flow distribution is balanced on each side of an element due to the flow having a higher flow friction in the lengthwise direction than in the widthwise direction.

Traditional heat exchanger design balances heat transfer with pressure drop. A tortous fluid flow across a heat transfer surface generates higher heat transfer, but at the same time suffers from increased pressure drops. Heat exchangers with increased pressure drops are less energy efficient, as more energy is required to circulate the heat transfer media. In traditional heat exchanged design it is assumed that all area of heat transfer surfaces provide an equivalent heat transfer. In reality, the flows are not evenly spread on the two sides of the heat transfer surface. The unbalanced flow results in different areas of the heat exchange surface having different surface flows resulting in, for example, greater warm flow in a given area as opposed to a greater cooling flow. Even where an extremely large heat transfer surface is available it cannot be assumed that the two flows will be equivalent. The greater of the flows is never fully changed in temperature where the

smaller flow is not be able to supply or absorb a sufficient amount of energy. The local imbalances of the flows adversely influence the total heat transfer of the heat exchanger.

In heat exchange equipment with similar placement of input and output ports as in the present non-obvious invention there will always be a tendency for the flows on each respective side to pass along the shortest distance. This will result in a warm flow concentrating on one side of the bundle and a cool flow concentrating along the opposite side of the bundle. This obviously leads to non-complete heat transfer between two flows.

In the presently cited references, *ACV* and *Usher,* this problem is not acknowledged and/or dealt with. The present non-obvious invention's solution to this problem is to provide the heat exchanger surface in a pattern whereby the resistance to flow is greater along the intended direction of flow then it is in the transverse direction. This results in the flow spreading out in the transverse direction which allows for the lowest overall pressure drop as the flow is utilizing all of the available surface and at the same time the spread out flow maximizing the heat transfer as the hot and cold sides of the heat transfer surface have an even distribution of each respective medium. *ACV* and/or Us*h*er, alone or in combination do not teach, suggest or disclose the importance and the means for distributing the flows evenly on both sides of the heat

exchanger surface where the input and output ports for a given heat transfer medium is located on the same edge of the heat transfer bundle.

As the prior art fails to teach, suggest or disclose applicant's novel and non-obvious configuration, including but not limited to thermally balanced flow distribution, increased turbulence, and flow resistance that is greater in a lengthwise direction and in a widthwise direction rejection under 35 U.S.C. 103(a) was improper and claims 5 and 9 are patentable.

B. Claims 7–8 and 10–11 are patentable over *ACV* in view of *Usher* in further view of *Hultgren*

1. One Skilled In the Art Would Be Led Away From The Combination of *ACV, Usher* and *Hultgran*

As discussed above, one skilled in the art would not combine *ACV* and *Usher*. Further, one skilled in the art would not combine *Hultgran* with *ACV* and/or *Usher*. Obviousness cannot be established by combining the teachings of prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination. , *e.g. In re Lee*, 277 F.3d 1338, 1342-43 (Fed. Cir. 2002); *In re Fritch*, 972 F.2d 1260, 1265-67 (Fed. Cir. 1992); and *ACS Hosp. Sys., Inc. v. Montefiori Hosp.*, 732 F2d 1572, 1577 (Fed. Cir. 1984). Absent a showing in the prior art, the Examiner has impermissibly used "hindsight" occasioned by the applicant's teaching to hunt through the prior art with the claimed

elements and combine them as claimed. See, *e.g. In re Fritch*, 972 F.2d 1260, 1265-67 (Fed. Cir. 1992).

Hultgren expressly states that turbulence must not be created. See, e.g. *Hultgren* at column 1, lines 41, 42. Applicant respectfully asserts that the Examiner has improperly combined references where the references teach away from their combination.

The inventive heat exchange package is oriented inside the casing such that the lengthwise direction of each element is exposed to the respective fluid medium. *Hultgren* on the other hand, leaves both end portions of each heat exchange element free of profiles in order to form the inlet/outlet boxes for the flow mediums. In addition, *Hultgren* teaches an angle of inclination of the ridged pattern be 20° or less, preferably around 5°. This low approach angle is instrumental in that exchanger accomplishing its recirculation effect by not reaching turbulent flow.

The present invention on the other hand increases flow turbulence. The orientation of the heat exchange package and the angle of inclination of the corrugated pattern in the present invention causes turbulent flow, where the lengthwise flow component is higher in turbulence and friction than the widthwise component, thereby improving heat exchange.

Hultgren, conversely, claims its non-turbulent design improves heat exchange by recirculation of portions of the flow stream, while the present

design improves heat exchange through increasing the travel time in the lengthwise direction by providing a corrugation pattern that promotes additional friction and turbulence in that direction of flow.

As discussed above with respect to claims 5 and 9, it is well known that increased turbulence increases the energy to move the fluid through the exchanger. *Hultgren* goes to great lengths to repeatedly state that its configuration is arranged to avoid turbulence and increased pressure drop. See *Hultgren*, at e.g. column 1 lines 41-43. Further, *Hultgren* teaches a heat exchanger which achieves its desired objects while keeping the angles less than 20 degrees, preferably about 5 degrees.

One skilled in the art would not combine *ACV*, *Usher* and *Hultgren*. Further, Usher and Hultgren teach away from the present invention. Thus, rejection under 35 USC §103(a) was improper.

2. *ACV, Usher* and/or *Hultgran* Alone or in Combination Do Not Teach a Heat Exchanger with All the Limitations of Claims 7–8 and 10-11.

As discussed above *ACV* and/or *Usher* alone or in combination do not teach or suggest a heat exchanger with all the limitations of claims 5 and 9. *Hultgren* does not make up the deficiencies in *ACV* and/or *Usher*. Hultgren does not teach or suggest thermally balanced flow distribution, increased flow turbulence nor does it teach or suggest flow resistance that is greater in the lengthwise direction than the widthwise direction. Thus,

claims 7-8 and 10-11 are patentable over *ACV*, *Usher* and *Hultgren*, alone or in combination.

VIII. <u>Conclusion</u>

Claims 5 and 9 are patentable over *ACV* and *Usher*. One skilled in the art would not combine *ACV* and *Usher*. Further, *ACV* and/or *Usher* alone or in combination do not teach or suggest a heat exchanger that includes all the limitations of claims 5 or 9. Thus, claims 5 and 9 are patentable. Claims 7-8 and 10-11 depend directly or indirectly from claim 5 or 9 and thus are patentable.

Claims 7-8 and 10-11 are patentable over *ACV*, *Usher* and *Hultgran*. One skilled in the art would not combine *ACV*, *Usher* and *Hultgran*. Further *ACV*, *Usher* and/or *Hultgran* alone or in combination do not teach or suggest a heat exchanger that includes all the limitations of claims 7-8 and 10-11. Thus, claims 7-8 and 10-11 are patentable.

Respectfully submitted,

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VIII. Claims Appendix

5. A recuperative heat exchanger for the exchange of heat across a plurality of heat transferring planar elements between a first fluid medium and a second fluid medium, said fluid mediums flowing in opposite directions to each other on opposite sides of said planar elements, said heat exchanger comprising:

a casing for containing a heat transfer package therein, said casing having a top end, a bottom end, a pair of respective lengthwise and widthwise opposed sides, each of said lengthwise sides provided with a pair of inlet and outlet ports, wherein each respective pair of inlet and outlet ports is dedicated to one of said first and second mediums for flow therethrough;

a heat transfer package disposed within said casing, said heat exchange package having a lengthwise extent and a widthwise extent, each of the fluid mediums following on their respective side of the planar elements a net flow path which extends longitudinally along the lengthwise extent, said package comprised of a plurality of generally rectangularly shaped planar elements continuously arranged in sequentially alternating directions in a folded accordion-like manner, each of said planar elements having substantially similar length, width and thickness with respect to each other, each of said planar elements integrally connected to an adjacent planar element along said length, said length and width of said casing substantially corresponding to said length and width of said package, opposing surfaces from each adjacent planar element defining an inter-layer space therebetween for receiving a flow of one of said fluid mediums therebetween, a direction of flow of each medium having a widthwise element and a lengthwise element when flowing within said inter-layer space, each of said planar elements having a corrugated pattern formed therein, said corrugated pattern extending the entire length and width of each respective planar element, said pattern corresponding to a series of alternating ridges and channels extending across the width of each respective planar element formed at an angle of more than 45 degrees with respect to said length of said planar elements, which pattern, in respect to the net flow path, are oriented in a more transverse than lengthwise direction, said corrugated pattern interrupted at substantially similar intervals to include a fold line for facilitating arranging each of said planar elements in an accordion-like manner, said fold lines defining said width of each respective element and being disposed parallel along said length of each of said elements, wherein when said heat transfer package is in an unfolded state, a

pattern of ridges and channels of a first planar element is generally aligned with respect to a pattern of channels and ridges of a successive planar element, and

wherein when said heat transfer package is in a folded state, said pattern on every other planar element is co-extensive to the other and said ridges and channels between facing sides of adjacent planar elements form a crossing pattern to each other such that said crossing pattern creates a flow resistance to said respective fluid medium flowing over said respective side of said planar element, the ridges and channels being arranged at an angle greater than 45 degrees with respect to a line arranged in a direction along the lengthwise extent so as to present a flow resistance greater in the lengthwise extent direction than the widthwise extent direction, the angle of the ridges and channels tending to increase the overall pressure drop across the heat exchanger compared to smaller angle configurations and force the fluid medium to travel more readily in the widthwise directions before exiting the heat exchanger, the angle of the ridges and channels arranged to force the fluid medium to exhibit a substantially thermally balanced flow distribution across the widthwise extent of the heat exchanger surfaces, thereby increasing flow turbulence and heat transfer.

7. A recuperative heat exchanger as claimed in claim 5 wherein:
said casing is sealed at said top and bottom ends by covering elements.

8. A recuperative heat exchanger as claimed in claim 7 wherein:
said covering elements are formed from a compound which solidifies upon cooling or by chemical reaction.

9. A recuperative heat exchanger for the exchange of heat across a plurality of heat transferring planar elements between a first fluid medium and a second fluid medium, said fluid mediums flowing in opposite directions to each other on opposite sides of said planar elements, said heat exchanger comprising:

a casing for containing a heat transfer package therein, said casing having a top end, a bottom end, a pair of respective lengthwise and widthwise opposed sides, each of said lengthwise sides provided with a pair of inlet and outlet ports, wherein each respective pair of inlet and outlet ports is dedicated to one of said first and second mediums for flow therethrough;

a heat transfer package disposed within said casing, said heat exchange package having a lengthwise extent and a widthwise extent, each of the fluid mediums following on their respective side of the planar elements a net flow path which extends longitudinally along the lengthwise extent, said package comprised of

a plurality of generally rectangularly shaped planar elements continuously arranged in sequentially alternating directions in a folded accordion-like manner, each of said planar elements having substantially similar length, width and thickness with respect to each other, each of said planar elements integrally connected to an adjacent planar element along said length, said length and width of said casing substantially corresponding to said length and width of said package, opposing surfaces from each adjacent planar element defining an inter-layer space therebetween for receiving a flow of one of said fluid mediums therebetween, a direction of flow of each medium having a widthwise element and a lengthwise element when flowing within said inter-layer space, each of said planar elements having a corrugated pattern formed therein;

said corrugated pattern extending the entire length and width of each respective planar element, said pattern corresponding to a series of alternating linear ridges and channels extending across the entire width of each respective planar element, said corrugated pattern interrupted at substantially similar intervals to include a fold line for facilitating arranging each of said planar elements in an accordion-like manner, said fold lines defining said width of each respective element and being disposed parallel of said length of each of said elements, wherein when said heat transfer package is in an unfolded state, a pair of ridges and channels of a first planar element is generally aligned with respect to a pattern of channels and ridges of a successive planar element, and

whereby said flow path has means for creating a flow resistance to said respective mediums such that the flow resistance to said respective mediums flowing over said respective side of said planar elements is greater in said lengthwise direction of said heat transfer package than in said widthwise direction, thereby increasing flow turbulence and heat transfer.

10. A recuperative heat exchanger as claimed in claim 9 wherein:
said casing is sealed at said top and bottom ends by covering elements.

11. A recuperative heat exchanger as claimed in claim 10 wherein:
said covering elements are formed from a compound which solidifies by cooling or by chemical reaction.

X. Related Proceedings Appendix

Applicant's legal representatives submit that there are no known appeals and interferences related to this appeal (see element II).

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Mail Stop Appeal Brief - Patents Commissioner of Patents, Box 1450 Alexandria VA 22313 on 20 July 2006.

Elizabeth McAleese